

PC HOUSE FOR INCHEON BRIDGE PILE-CAP

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1. INTRODUCTION

1.1 PC House

After completion of RCD (a kind of drilled shaft foundations) works, the structure acting as a cofferdam and a working plate was required for the bridge's substructure work(on the sea). Thus, the concrete structure called as PC House is adopted for the project.

PC House was manufactured at the fabrication yard, and transferred to the marine site by using a floating crane. It was set on the RCD piles. This process is to minimize the works on the marine site, reduce the construction period, secure the concrete quality, and improve the constructability of substructure.

Material quantity, specifications, and type of material are as following.

Table.1 Material Quantity & Spec.

Section		Qty. (EQ)	Spec.(L×W×H)	Remarks
Viaduct	W11~19 E11~19	36	11m×11m×4m	
Approach Bridge	W4~10 E4~10	14	28.2m×13m×5m	
CSB	W1,E1	4	70m×25m×5.4m (Parcel:35m×25m×5.4m)	1 Section 2 Parcel
	W2,3 E2,3	4	34m×18m×4.5m	
Total	58(56 Sections)			

Table.2 Material Item

Section		Concrete	Rebar	Hook	Mold
Viaduct	W11~19 E11~19	138 m ³	29ton	8EA	bottom:4sets wall:2sets
Approach Bridge	W4~10 E4~10	372 m ³	126ton	16EA	bottom:2sets wall:1set
CSB	W1,E1	674 m ³	330ton	32EA	bottom:4sets wall:1set
	W2,3 E2,3	570 m ³	202ton	24EA	bottom:2sets wall:1set

1.2 Special Feature of Method

There are various methods available to be adopted for the bridge' substructure work (marine work) after RCD work such as cofferdam method, Steel House method, etc., besides of the PC House method adopted to the Incheon Bridge project. A cofferdam method is required too many of manpower/equipment/material since it is difficult and large scaled method. In case of Steel House method, its manufacture/installation process is simple and its weight is much lighter than PC House, so it is easy to work with equipment. However, its cost is expensive since it is made with steel material. Especially, there are several concerned matters such as steel corrosion, joint with Pile Cap, exterior aesthetic issues, so additional works would be required. Therefore, in view of the above, PC House method was adopted for the Incheon Bridge project.



Figure.1 PC House Manufacture



Figure.2 PC House Transportation

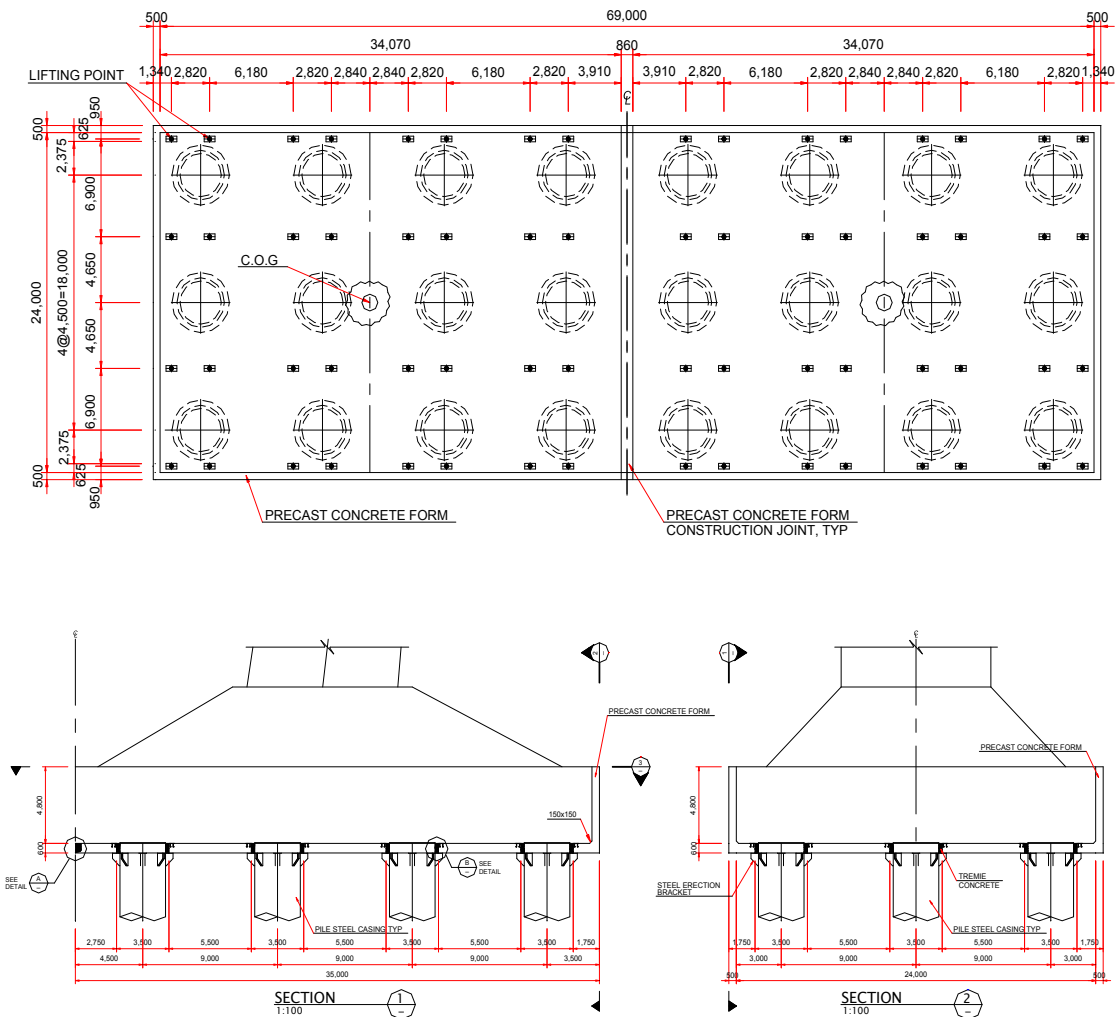


Figure.3 CSB(Pylon) Drawing

2. MAJOR TEMPORARY FACILITIES AND EQUIPMENT

2.1 Major Temporary Facilities

Bottom Form was made according to each PC House size. On the steel plate of the fabrication yard or the tamped ground, the rectangular bars(5cm×5cm) were arranged with 20cm interval and it was covered with 18mm thick of coating panel. If Leveling work is required in some section, the level of each rectangular bar was adjusted by using the non-shrinkage mortar before covered with the coating plywood. 6 sets for Viaduct, 2 sets for Approach Bridge, and 6 sets for CSB (Pylon-4 sets / End Section – 2 sets) were mobilized.

For Bottom Form (1st concrete), EURO Form was used.

Wall Form(2nd concrete) is manufactured with steel materials, and the required quantity is 2 sets for Viaduct, 1 set for Approach Bridge, and 2 sets for CSB (each for Pylon and End section).

For the opening on the bottom concrete of the PC House (it is to joint with RCD Piles), the circular steel form was separately manufactured.

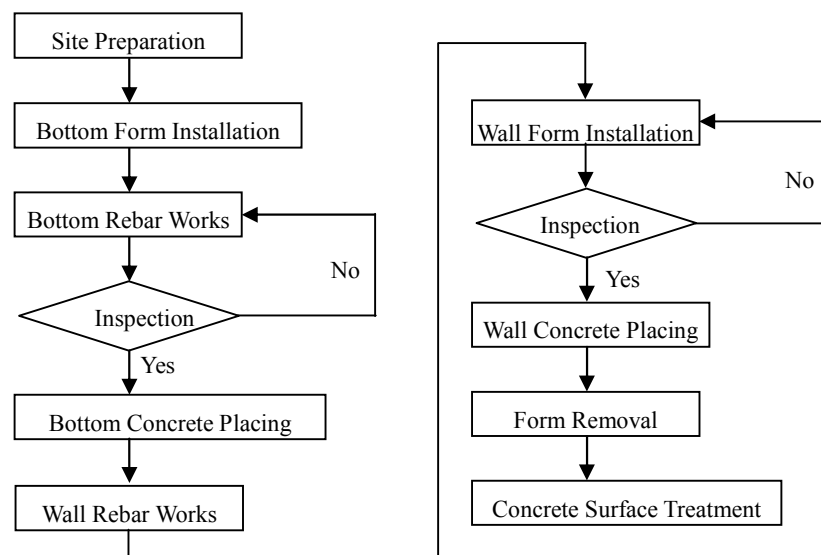
B.T Scaffolding was used for the rebar works (wall section) and other high place working. Simple Control System was used for steam curing for concrete placing during winter season.

2.2 Major Equipment

Crawler Crane was used for the rebar transportation and mold form installation/removal. According to the work purpose and PC House size, 50ton or 80ton crane was arranged.

Pump Car was used for concrete placing. And, considering the location of concrete placing and the PC House size, each size (32m, 36m, 43m) of pump car was arranged.

2.3 PC House Manufacture Flow Chart



3. DETAILED WORK METHOD

Site Preparation (Site Base Course Grading/Tamping)

PC House was usually manufactured on the steel plate of the fabrication yard, but some of PC House was manufactured on the earth work section. In order to secure the necessary bearing force of soil, the site base grading and tamping work was carried out.

Bottom Form Installation

After completion of the site preparation, the bottom form was installed considering the location and size of the PC House. For the bottom form, the rectangular bars(5cm×5cm) were installed with 20cm interval and it was covered with 18mm thickness of coating panel.

Bottom Rebar Work

- 1) After the bottom form installation, the rebar arrangement work for the bottom section was started. Before the rebar assembly, the position of the rebar and form was marked on the bottom form, and the location of the circular shaped form was accurately adjusted based on the results of the RCD works
- 2) Spacer and working bar were installed for rebar assembly. The ready-made spacer with more than 35MPa strength (Design strength of PC House) was used, and in order to prevent possible deflection of the rebar, 4EA/m² of spacer were used.
- 3) The location of RCD hole and the level of bottom form were checked and the location of the hole was adjusted based on the actual survey data and the measurement data of bottom form level.
- 4) The lap joint shall be tied with more than 3 points. The rebar work shall be checked based on the rebar work assembly drawing. (shape and size, rebar diameter, rebar interval, lap joint length, rebar length, cutting point, etc.)
- 5) After the bottom rebar arrangement, the wall rebars were arranged. Among the wall rebars, the rebars in vertical direction were arranged at the same time with the bottom rebars arrangement.
- 6) After the said rebar arrangement, PC cable was installed for lifting work. The used PC cable was with 45.6mm of diameter and 2 cables are installed for one lifting hook. 32EA of PC cables are installed for approach bridge, and 16EA for viaduct. For the CSB section, Dywidag bar was applied.
- 7) Anchor for installing the bracket to fix the wall form was embedded upon the lower section of rebar assembly.
- 8) Control-Valve to eliminate the sea water (which was come into the inside during PC House transportation and installation) was installed.
- 9) When every required accessory was installed, the circular shaped form was installed, including Ring Plate and H-beam which were arranged on the upper area of the form.
- 10) EURO form was used for the bottom form. The steel pipes were connected to the back side of the EURO form, and the rectangular bars were also used to firmly fix the form.
- 11) When most of the works for the upper part concrete placing work were completed, the rebar was arranged for the joint of Pile Cap and PC House. If the rebars arrangement for the said joint work is carried out, the available working space is very limited so the following works could be affected. Therefore, this rebars arrangement work was executed just before the concrete placing.

Bottom Concrete Placing

- 1) Concrete (compressive strength 35MPa & Slump $18\pm 2.5\text{cm}$) was produced at the Batcher Plant located in the fabrication yard, and it was transported to the PC House site for the concrete pouring. The engine-type vibrators (3ea) were used and 2ea of vibrators were prepared at the site as spare ones.
- 2) The height of concrete pouring was determined based on the mark indicated on the joint rebar of Pile Cap. The concrete surface was treated by man-power with trowel.
- 3) After the concrete placing, the curing compound was applied for the curing.
- 4) When the concrete was hardened and reached to a certain level during the curing after the application of the curing compound, it was watered and covered with curing cloth to maintain the damp condition.
- 5) After completion of curing, the concrete surface was treated in order to remove the laitance or loose aggregate on the construction joint section by using a wire-brush and hand-breaker and to make the surface be rough.
- 6) The form was removed.
- 7) The bottom section work was completed with the removal of the form and other works.

Wall Rebars Works

- 1) After completion of the bottom section work, the wall rebars were arranged. The wall rebars in vertical direction was already completed with the bottom section work, therefore, most of stirrups rebar work was carried out.
- 2) While executing the wall rebars work, the turnbuckles and wires were used to prevent possible overthrow of the rebars, and the location of rebars was also adjusted thru the same.
- 3) Bracket was installed for the wall outside form work. It was fixed with bolt on the anchor embedded upon the bottom form work. Originally, it was planned that the wall outside form would be fixed by using Support, however it makes difficult to adjust the location of the form and decrease the work efficiency. Therefore, this plan was changed to manufacture/install the bracket.
- 4) In order to prevent the overflow of the concrete mortar, some sponge was installed on the section between the bottom concrete and wall form before installation of the wall form.

Wall Form

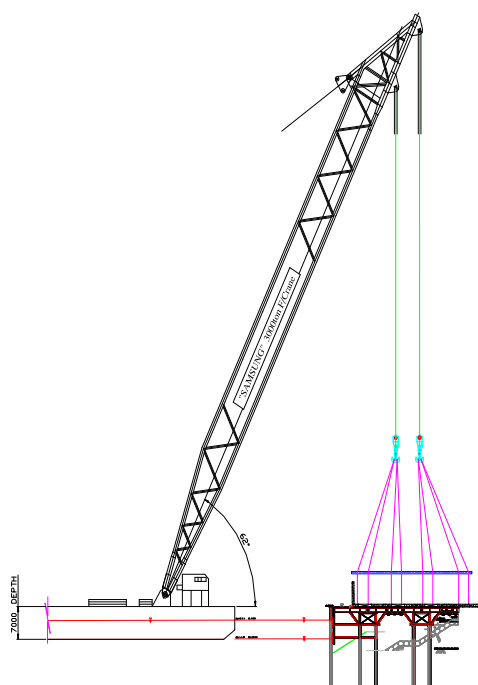
- 1) The wall form was installed by using Crane. The form was placed on the bracket, and fixed by using Prop. And, the fine turning for the form position was made.
- 2) The water stop type form tie was applied to fix the outside form and the inside form in order to prevent water. The form tie was installed on the certain location after installation of outside form. And, it was adjusted after installation of inside form.
- 3) The inside form was installed by using Crane, and the form tie assembly was completed.
- 4) After completion of inside/outside form work, their level and geometry was adjusted. (Level by Bracket & Geometry by Slope Support) And, the bolting for the form work was executed.

- 5) In order to prevent the occurrence of a gap or deflection on the form bottom section, square bars were additionally installed.
- 6) The form work was completed.

Wall Concrete Placing

- 1) After the form work, the concrete placing work commenced. Concrete (compressive strength 35MPa & Slump 18 ± 2.5 cm) was produced at the Batcher Plant located in the fabrication yard, and it was transported to the PC House site for the placing. The engine-type vibrators (3EA) were used and 2EA of vibrators were prepared at the site as spare ones.
- 2) When the surface moisture was settled down after the concrete placing, the curing compound was applied. And, it was covered with the curing cloth to maintain the wet condition when the concrete was hardened.

Then, the form was removed by using Crane. After the form removal, the surface of the construction joint section was treated, and the hole of Form Tie was filled up. The lifting capacity was reviewed according to PC House Fabrication Yard Layout. (CSB W1&E1)



Equipment	Boom Angle	Working Radius	Lifting Capacity	Remarks
3000ton F/C	63 degree	38.7M	2,890Ton	

PC House Weight : 1,750Ton
 Lifting Frame Weight : 229Ton
 Total Lifted Weight : 1,979Ton

Figure.4 CSB Pylon's PC House (3000ton F/C)

3. CONCLUSION

PC House of the Incheon Bridge including the cable-stayed bridge pylon in the private investment section is very large and requires a high quality in fabrication on the casting yard. Also it needs very sophisticated erection method. Finally we could accomplish the successful construction of pile cap structure for the sake of these perfect PC House.